

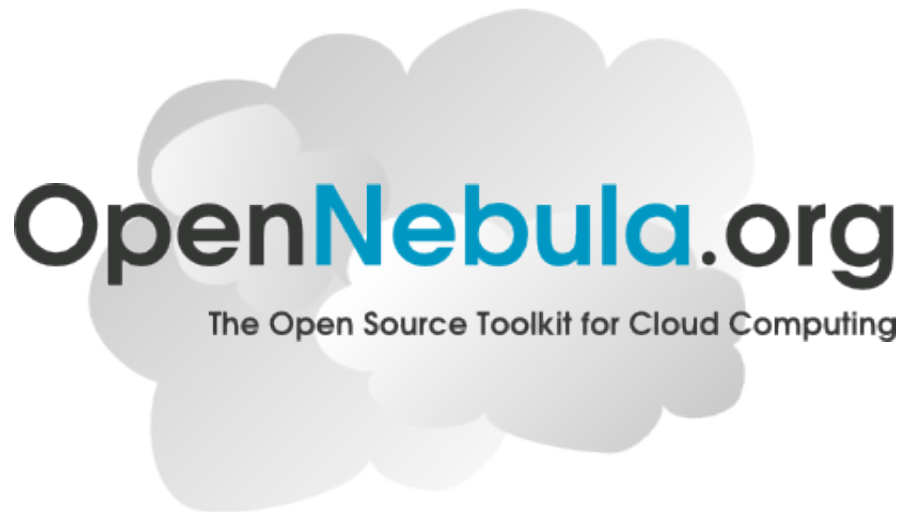
The logo features a stylized, multi-colored cloud shape in the background, composed of overlapping circles in shades of light blue, medium blue, and grey. Overlaid on this cloud is the text "OpenNebula.org".

OpenNebula.org

The Open Source Toolkit for Cloud Computing

The OpenNebula Cloud Toolkit: Experiences and Outlook

Borja Sotomayor
University of Chicago



What is OpenNebula?

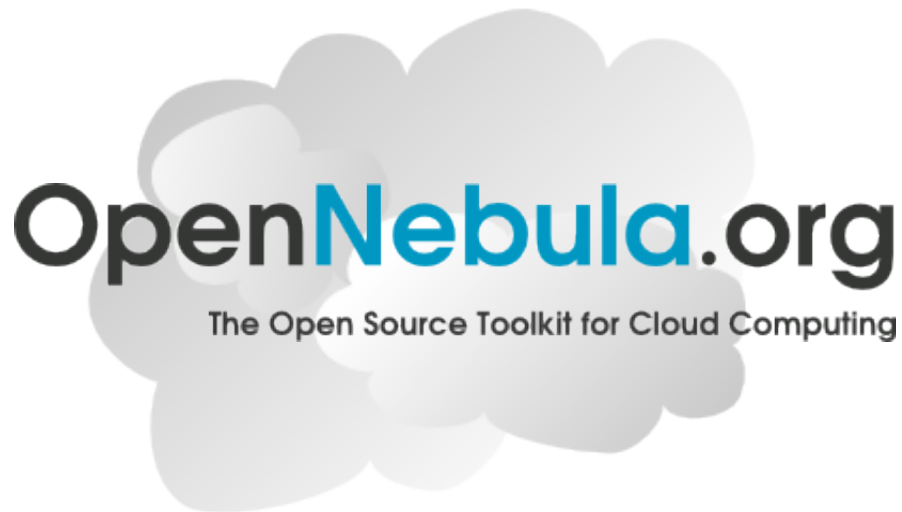
Experiences

Ecosystem

Outlook

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What is OpenNebula?

Experiences

Ecosystem

Outlook

Software as a Service



facebook



Google docs

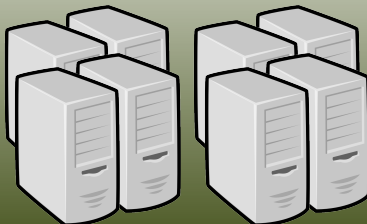
Platform as a Service



Windows Azure

force.com™
platform as a service

Infrastructure as a Service

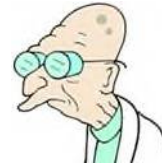


Physical Infrastructure



flexiscale™

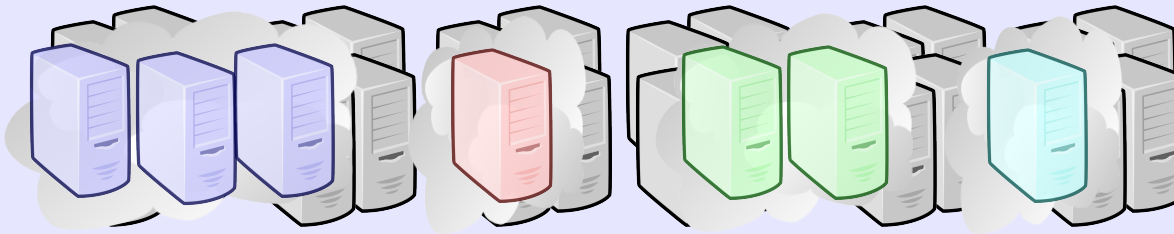




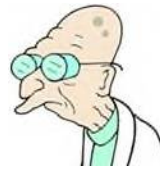
IaaS

Public Interface

Virtual Infrastructure Manager



Physical resources with Virtual Machine
Managers (Xen, KVM, VMWare, etc.)



External
Users



Internal
Users

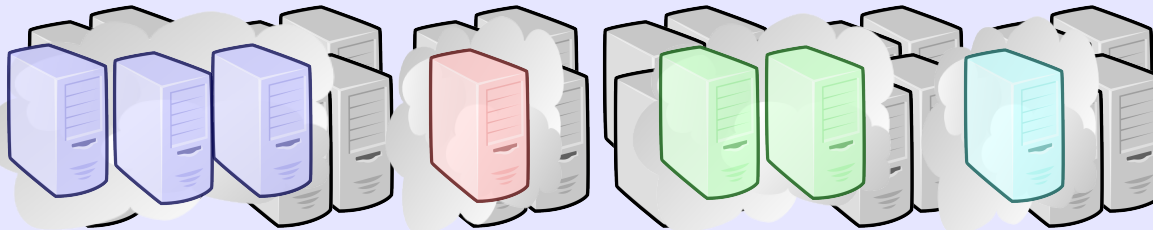
Public Interface

Internal Interface

Private Cloud

Hybrid Cloud

Virtual Infrastructure Manager



Physical resources with Virtual Machine
Managers (Xen, KVM, VMWare, etc.)

External
Cloud

~~OpenNebula is a virtual infrastructure manager~~*

OpenNebula is a standards-based
open-source **toolkit** to build private,
public and hybrid clouds.



Most development takes place at the University
Complutense of Madrid, and is funded by several
European and Spanish grants.
Project has been ongoing since 2005.

* Managing VMs is a big part of building an IaaS cloud, but not the only part.

Why a “toolkit”?

End-User

Wants cloud interfaces to manage virtual machines, network and storage.

Prefers popular interfaces like Amazon EC2

Multi-tier services as a basic management entity

Wants cloudbursting to public clouds and possibly to partner clouds.

Cloudbursting must be transparent to users

Sysadmin

Wants administration interface.

Needs control over resource allocation policies

May have to support existing data center services.

One solution does not fit all requirements and constraints.

Needs to integrate with products and services in the virtualization/cloud ecosystem such as cloud providers, hypervisors, virtual image managers, service managers, management tools, schedulers. . .

Must be easy to add new functionality and to embed into other platforms.

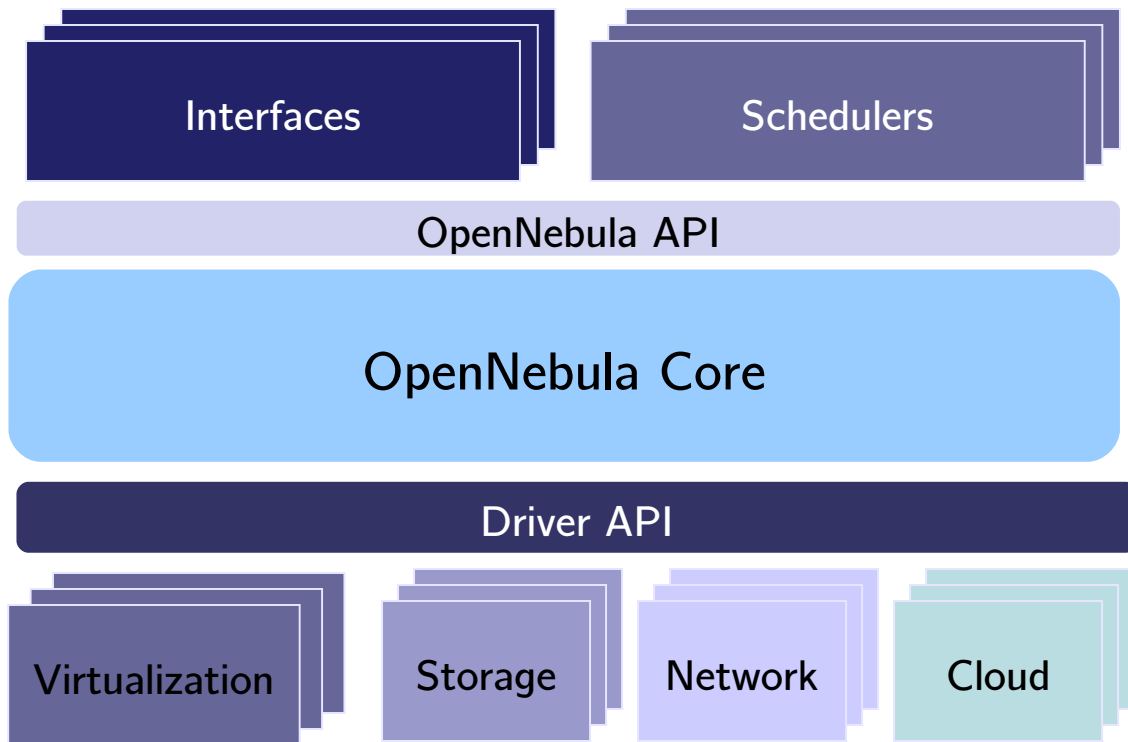
The OpenNebula design philosophy

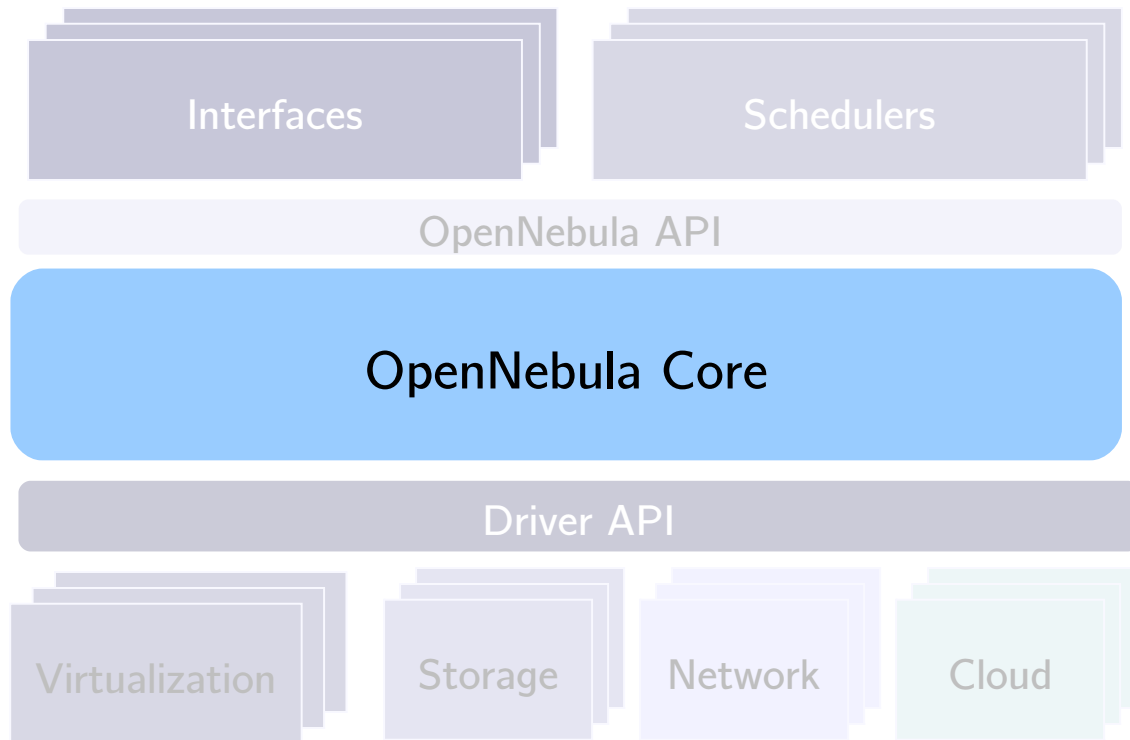
There cannot be turnkey solutions for IaaS clouds,
so OpenNebula shouldn't aim to be one.

First and foremost, provide an architecture that is open,
flexible, and extensible that allows multiple components to
be orchestrated.

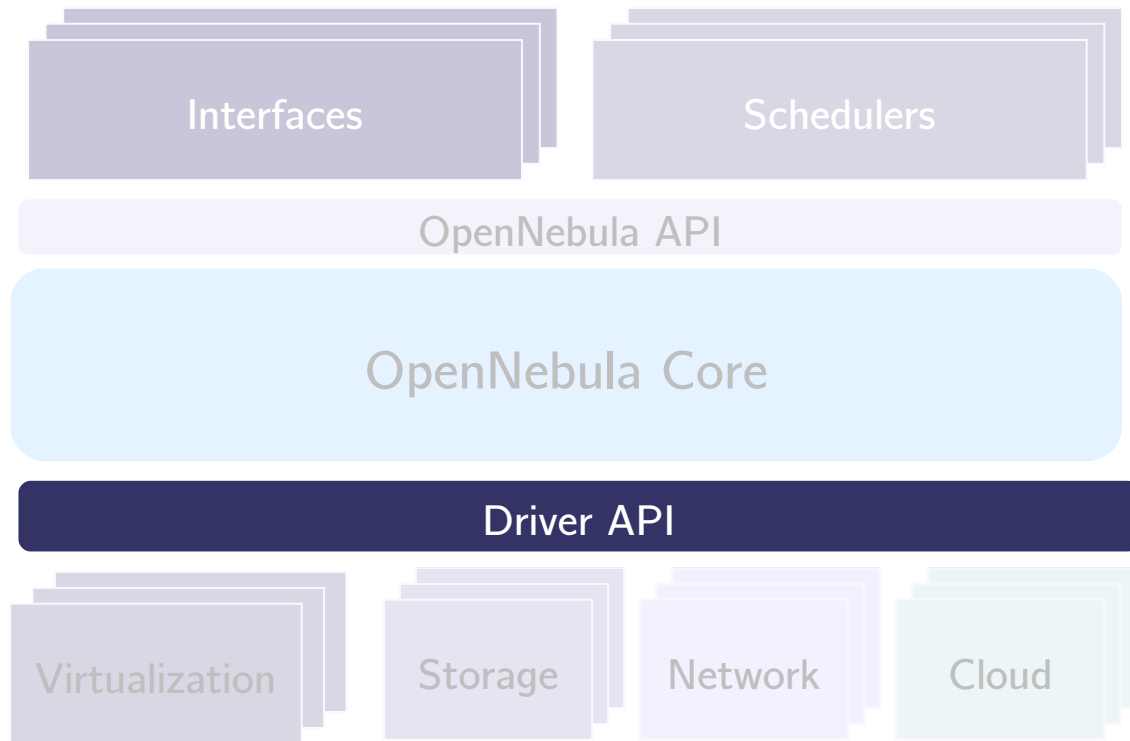
Provide some components of our own, but allow them to
be easily replaceable by others.

Seriously, though, what *is* OpenNebula?



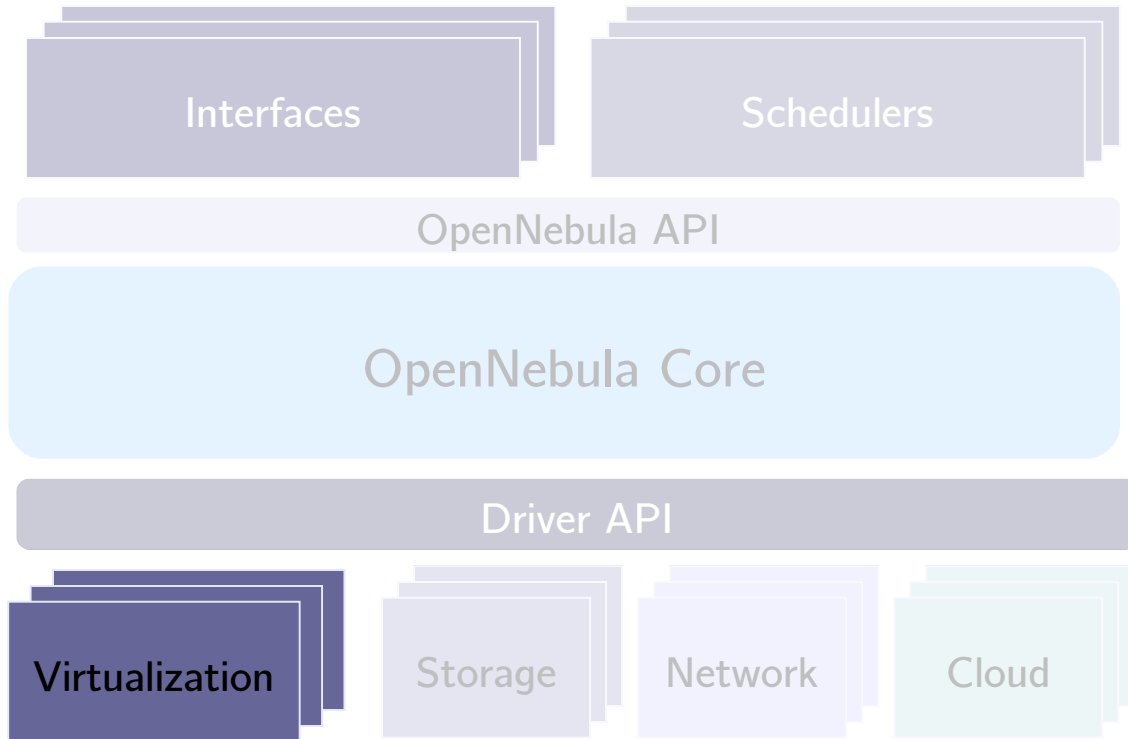


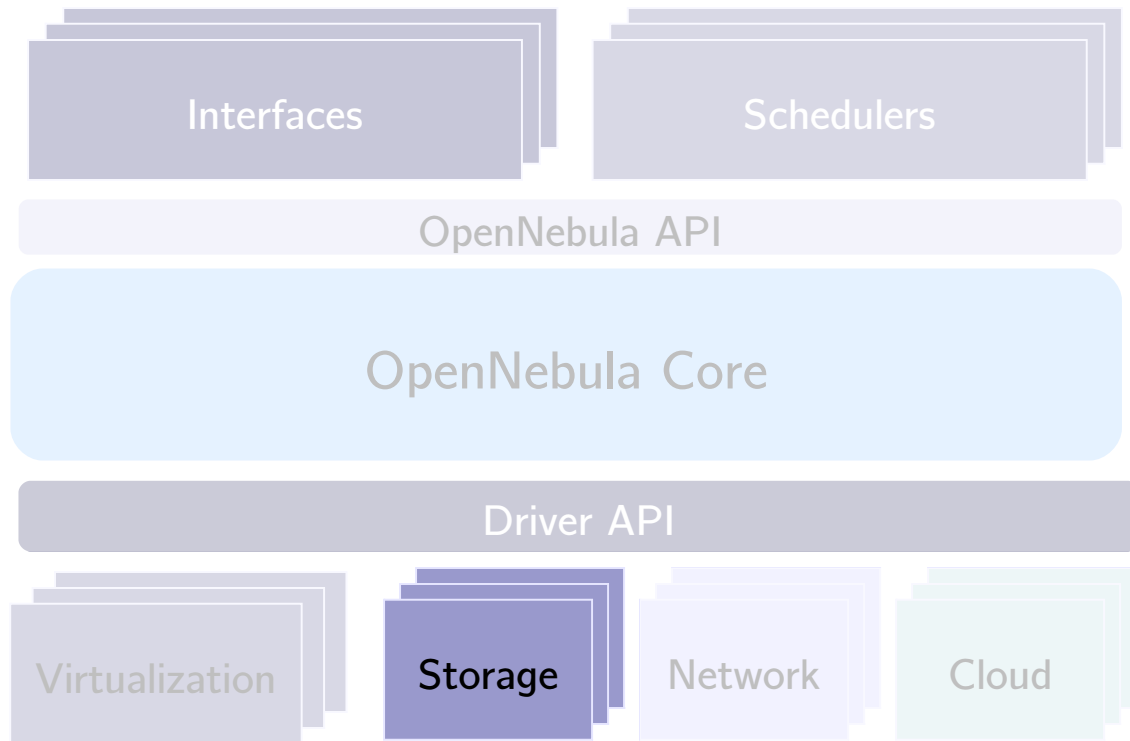
Handles orchestration of all the different components.
Also handles some cross-cutting features, such as user management, persistence, etc.



Provides a layer of abstraction over lower-level operations.

Drivers are self-contained and can be written without modifying OpenNebula's core.



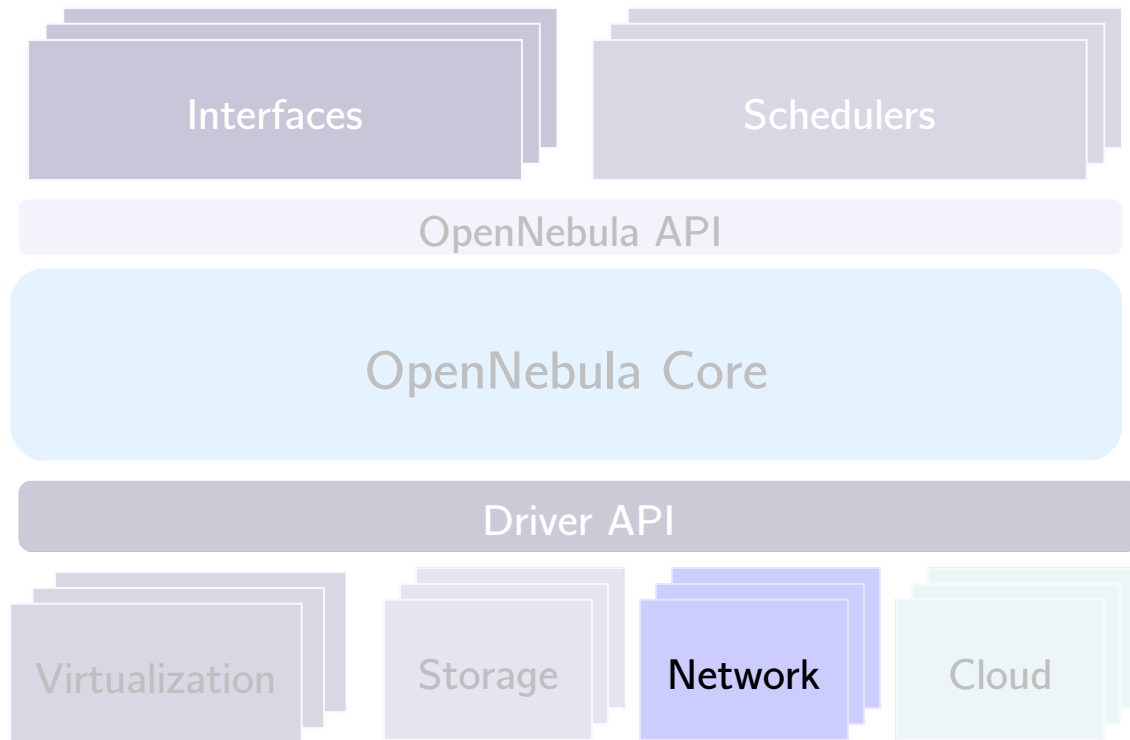


Images on
shared NFS

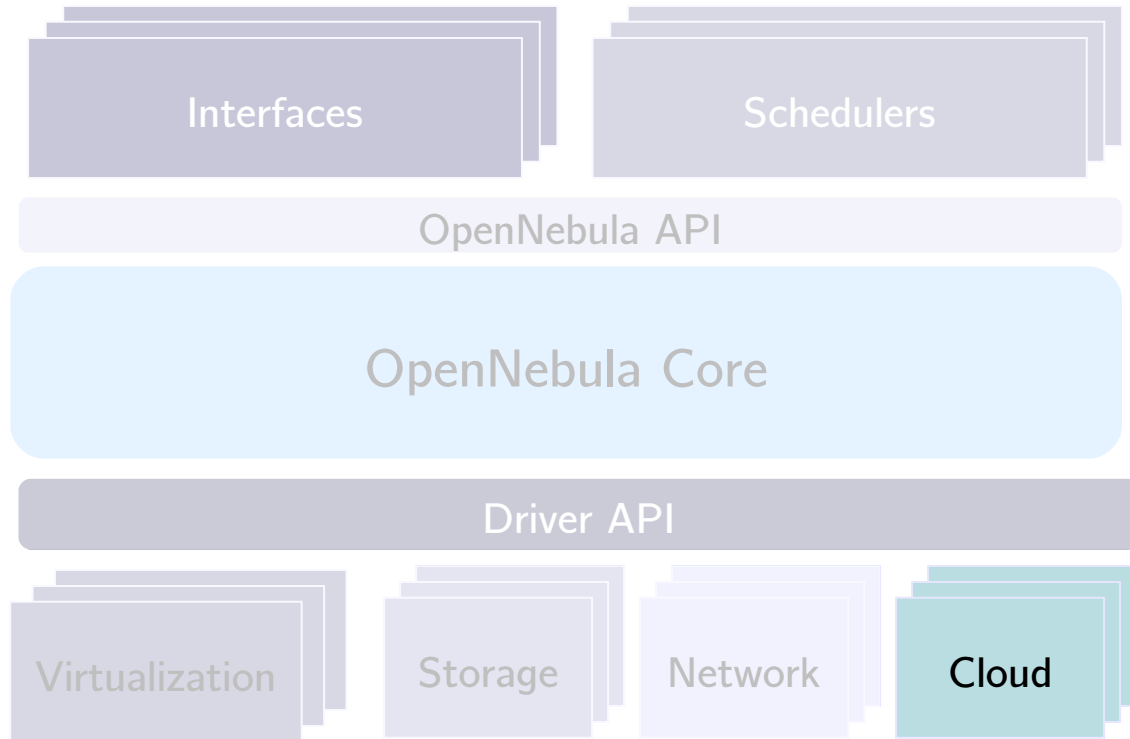
SCP from
image repository

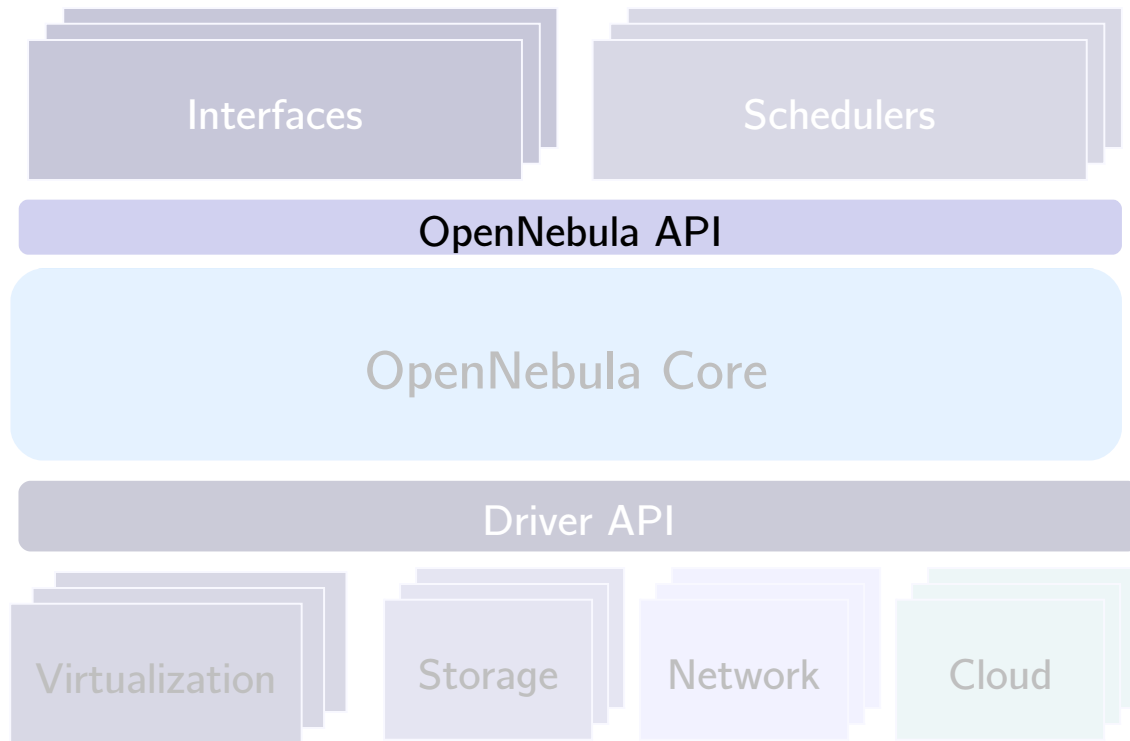
LVM

Contextualization of disk images



Creation of virtual networks

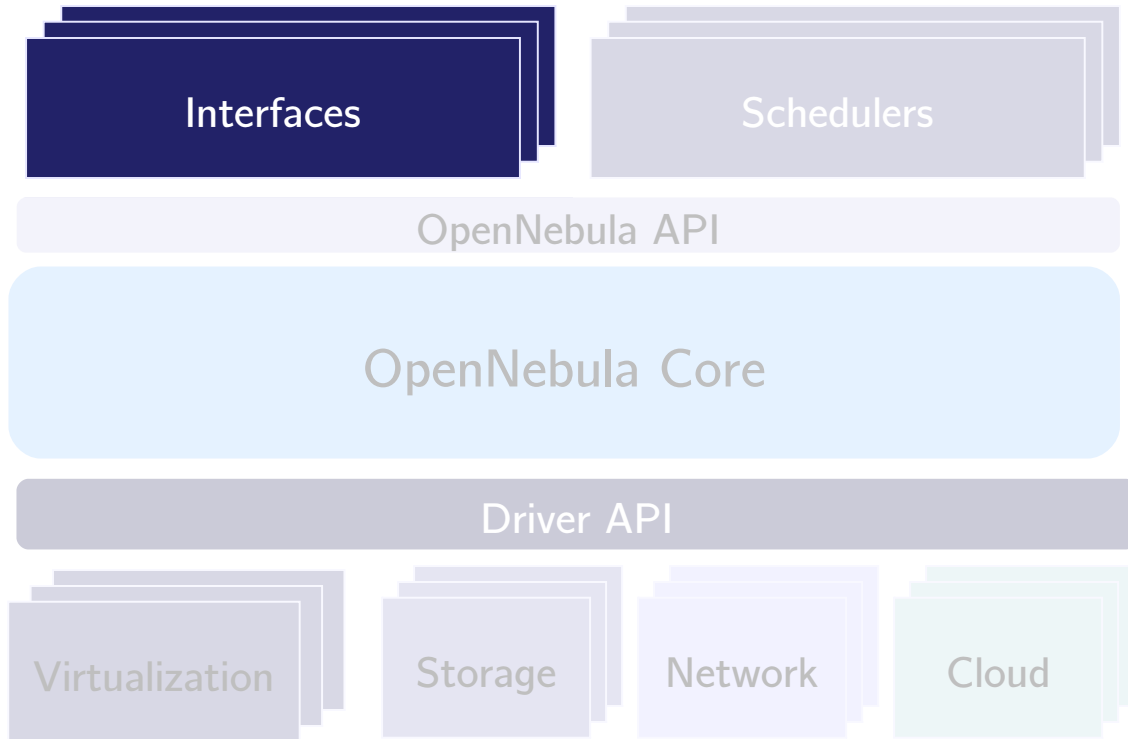


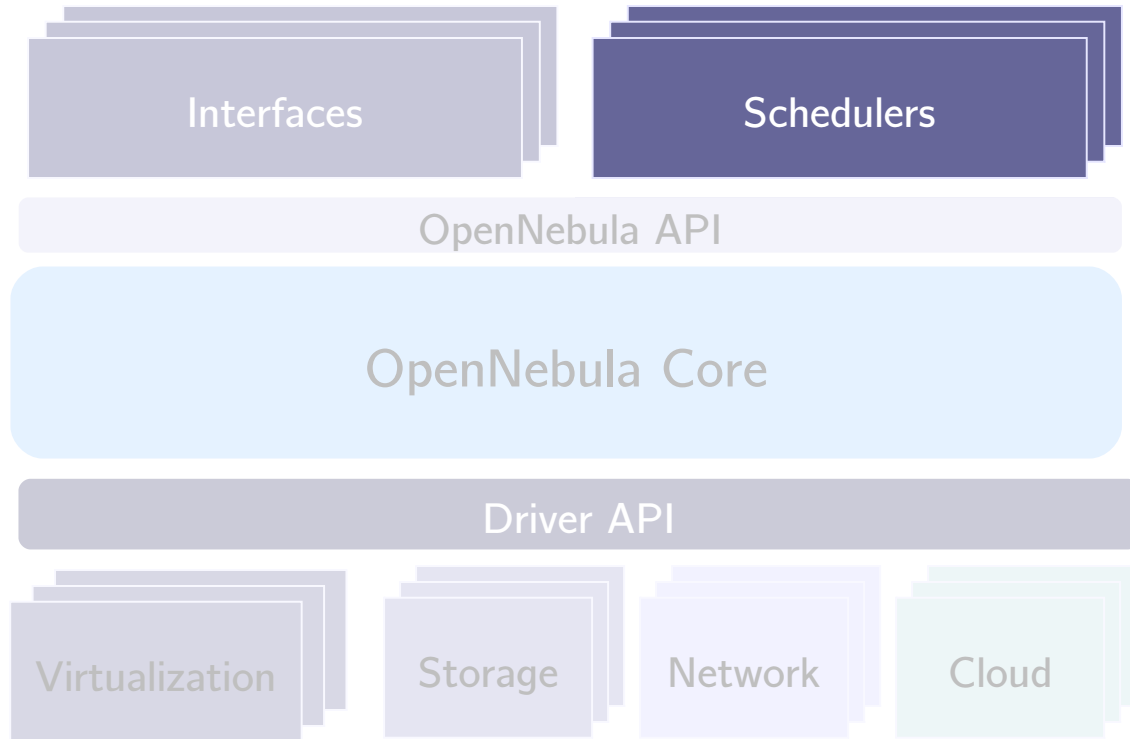


XML-RPC

CLI

OpenNebula Cloud API





Matchmaking scheduler with a configurable ranking policy

Geared towards immediate scheduling, with basic queueing

How does it compare to other solutions?



SurfNET, SURFnet cloud computing solutions, University of Amsterdam. 03/12/2010

<http://tinyurl.com/surfnet-opennebula>



BiG Grid, *Virtualization of worker nodes*, Working group progress report. 02/02/2010

<http://tinyurl.com/big-opennebula>



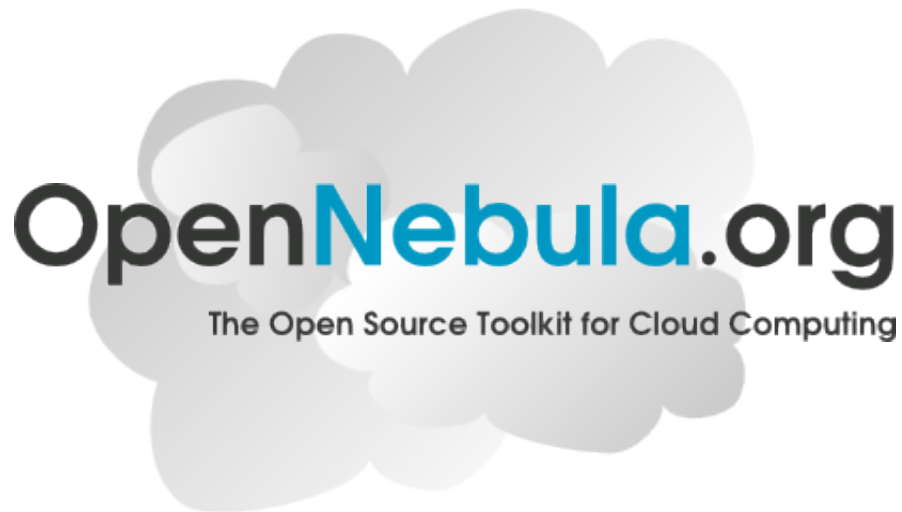
Cerbelaud, D., Garg, S., and Huylebroeck, J. *Opening the clouds: qualitative overview of the state-of-the-art open source VM-based cloud management platforms*. In Proceedings of the 10th ACM/IFIP/USENIX international Conference on Middleware 2009



B.Sotomayor, R.Santiago Montero, I.Martín Llorente, I.Foster, *Virtual Infrastructure Management in Private and Hybrid Clouds*. IEEE Internet Computing, vol. 13, no. 5, pp. 14-22, Sep./Oct. 2009.

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What is OpenNebula?

Experiences

Ecosystem

Outlook

A team at Clemson University and CERN has used OpenNebula to deploy up to ~8,000 VMs on 500 physical hosts running Xen.

These VMs are used to run batch jobs (submitted via WLCG CE and managed by LSF)

Used XML-RPC API to add certain autonomic functionality that was important to them, and to integrate with CERN's Quattor (<http://www.quattor.org/>)

Created, and contributed, drivers for using LVM-based disk images.

More details at <http://tinyurl.com/opennebula-blog-cern>





The D-Grid (national German Grid initiative) Resource Center Ruhr (DGRZR) has used OpenNebula to manage 250 Blades with a total of 2,000 cores.

Entire D-Grid software stack is run on VMs. Grid worker nodes currently managed with OpenNebula, frontend nodes to follow shortly.

More details at

<http://tinyurl.com/opennebula-blog-dgrzr>

SARA is the Dutch National High Performance Computing and e-Science Support Center, and the Dutch supernode in the international Science Grid.

They are currently developing an HPC cloud that uses OpenNebula. Users get their own 'Virtual Private HPC Cluster'



Starting with 128 cores across 16 physical machines running KVM.

Users use a management console developed at SARA to request a new VM. Templates are provided, but users can also configure their own.

More details at

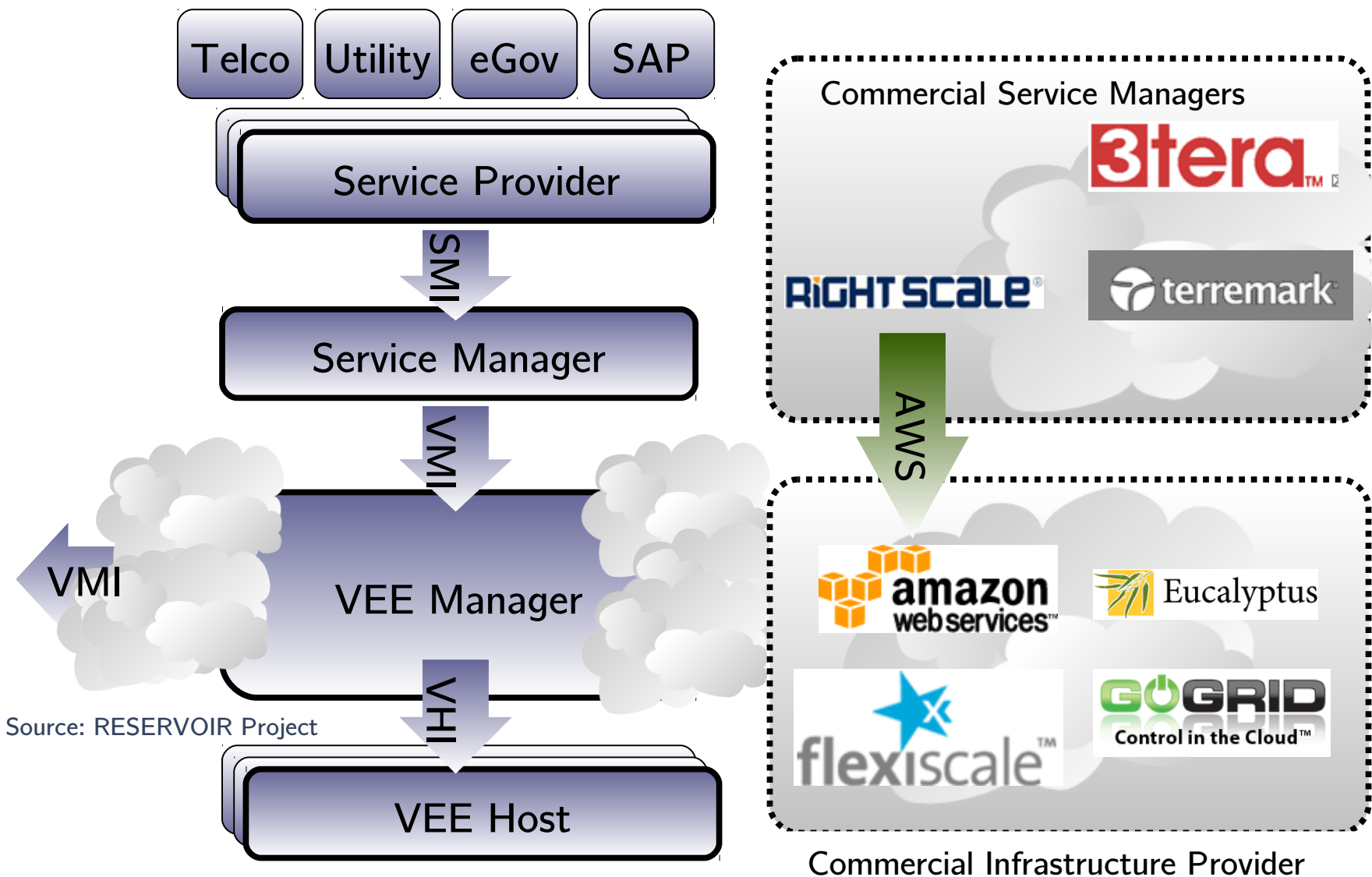
<http://tinyurl.com/sara-opennebula> and

<http://tinyurl.com/opennebula-sara-cfengine>



The BiG Grid Virtual Machine Working Group (in NIKHEF) did an evaluation of several cloud solutions, and recommended using OpenNebula for managing worker node VMs in BiG Grid.

More details at
<http://tinyurl.com/big-opennebula>



Research with OpenNebula

Cloud architectures, federation, interoperability

- B. Sotomayor, R. S. Montero, I. M. Llorente and I. Foster, *Virtual Infrastructure Management in Private and Hybrid Clouds*, IEEE Internet Computing, September/October 2009 (vol. 13 no. 5)
- B. Rochwerger, J. Caceres, R.S. Montero, D. Breitgand, E. Elmroth, A. Galis, E. Levy, I.M. Llorente, K. Nagin, Y. Wolfsthal, *The RESERVOIR Model and Architecture for Open Federated Cloud Computing*, IBM Systems Journal, Vol. 53, No. 4. (2009)

High Performance Computing (HPC) clouds

- R. Moreno, R. S. Montero, e I. M. Llorente, *Elastic Management of Cluster-based Services in the Cloud*, First Workshop on Automated Control for Datacenters and Clouds (ACDC09)
- I. M. Llorente, R. Moreno-Vozmediano, and R. S. Montero, *Cloud Computing for On-Demand Grid Resource Provisioning*, Advances in Parallel Computing, Volume 18 (2009): “High Speed and Large Scale Scientific Computing”, pp. 177 - 191. IOS Press, 2009.
- B. Sotomayor, R. S. Montero, I. M. Llorente and I. Foster, *Resource Leasing and the Art of Suspending Virtual Machines*, IEEE International Conference on High Performance Computing and Communications (HPCC-09), Seoul, Korea

Research with OpenNebula

Service Management

- Luis Roderó-Merino, Luis M. Vaquero, Victor Gil, Fermín Galán, Javier Fontán, Rubén S. Montero, and Ignacio M. Llorente, *From infrastructure delivery to service management in clouds*, Future Generation Computer Systems. In press

Energy-efficient cloud computing

- G. von Laszewski, L. Wang, A. J. Younge, X. He, *Power-Aware Scheduling of Virtual Machines in DVFS-enabled Clusters*, Proceedings of IEEE International Conference on Cluster Computing and Workshops, 2009. CLUSTER '09.

OpenNebula in industry



CloudScaling (<http://cloudscaling.com/>)

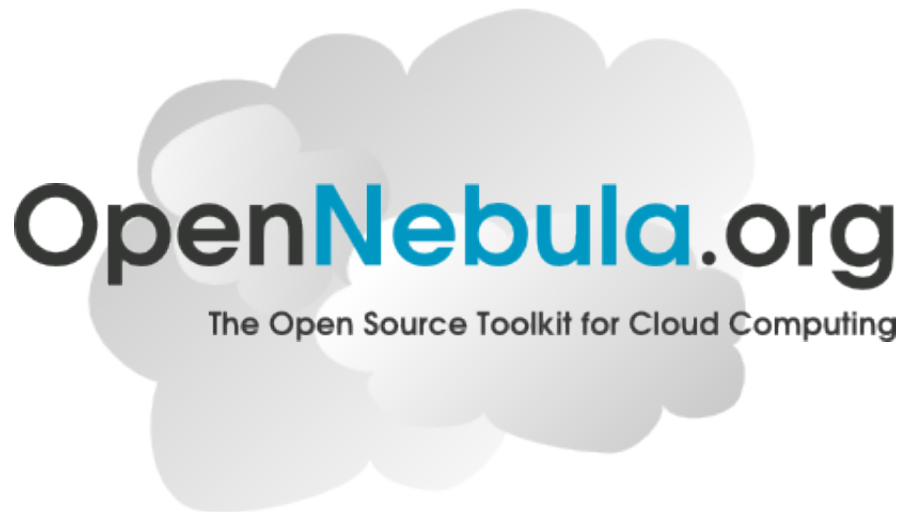
According to Randy Bias, CEO, “*Cloudscaling has had great success with OpenNebula. Unlike many of the other open source virtual infrastructure management tools, ONE is cleanly written, modular, and easily extensible. We use it regularly in our labs and in some client engagements. Highly recommended.*”



Morph Labs (<http://www.mor.ph/>) uses OpenNebula in its mCloud Controller product.

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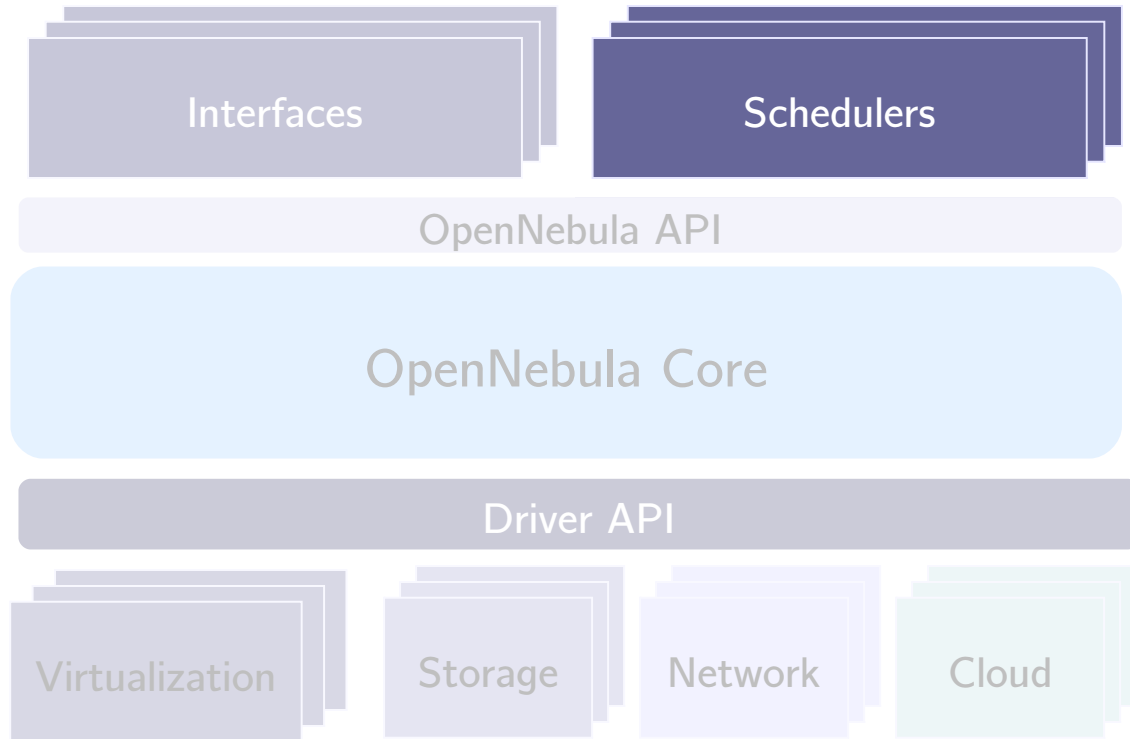


What is OpenNebula?

Experiences

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More featureful scheduler, including support for advance reservation, queueing, and pluggable scheduling policies.

Developed at the University of Chicago

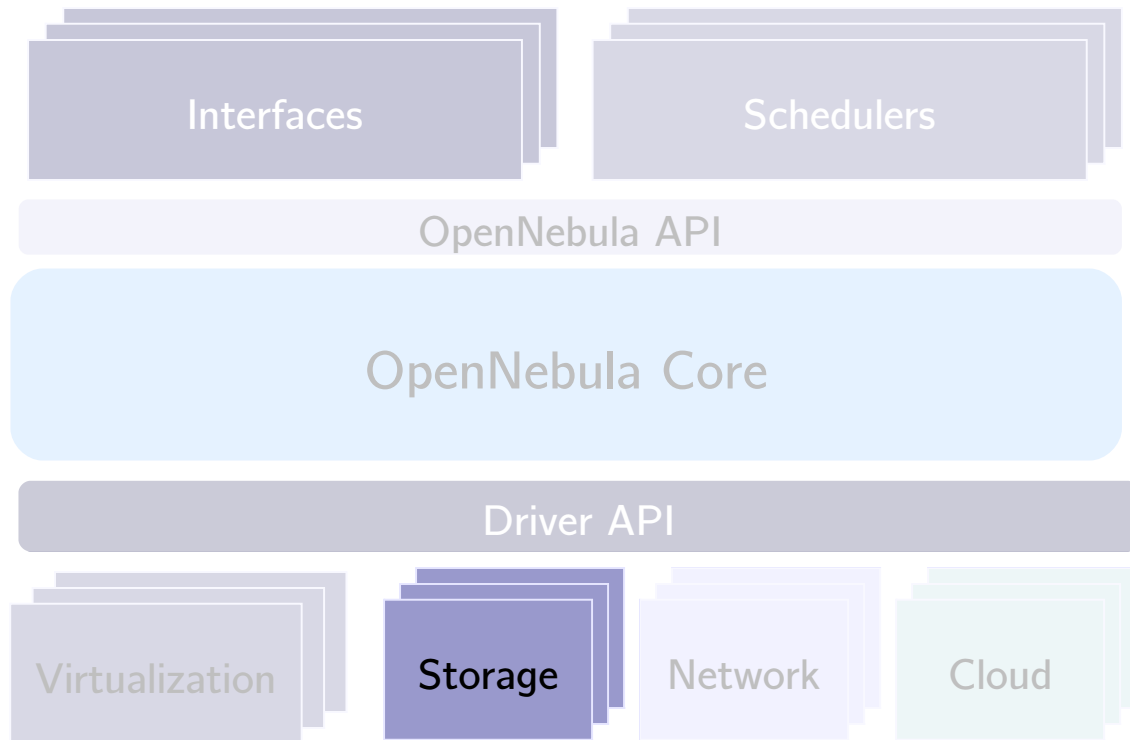
<http://haizea.cs.uchicago.edu/>



Haizea is a lease manager that can act as a scheduling backend for OpenNebula, providing advanced functionality such as:

- Advance reservation of capacity
- Best-effort scheduling with backfilling
- Resource preemption (using VM suspend/resume/migrate)
- Policy engine, allowing developers to write pluggable scheduling policies in Python
- Includes a simulation mode (useful for researchers testing scheduling algorithms)

Haizea research publications: <http://haizea.cs.uchicago.edu/pubs.html>

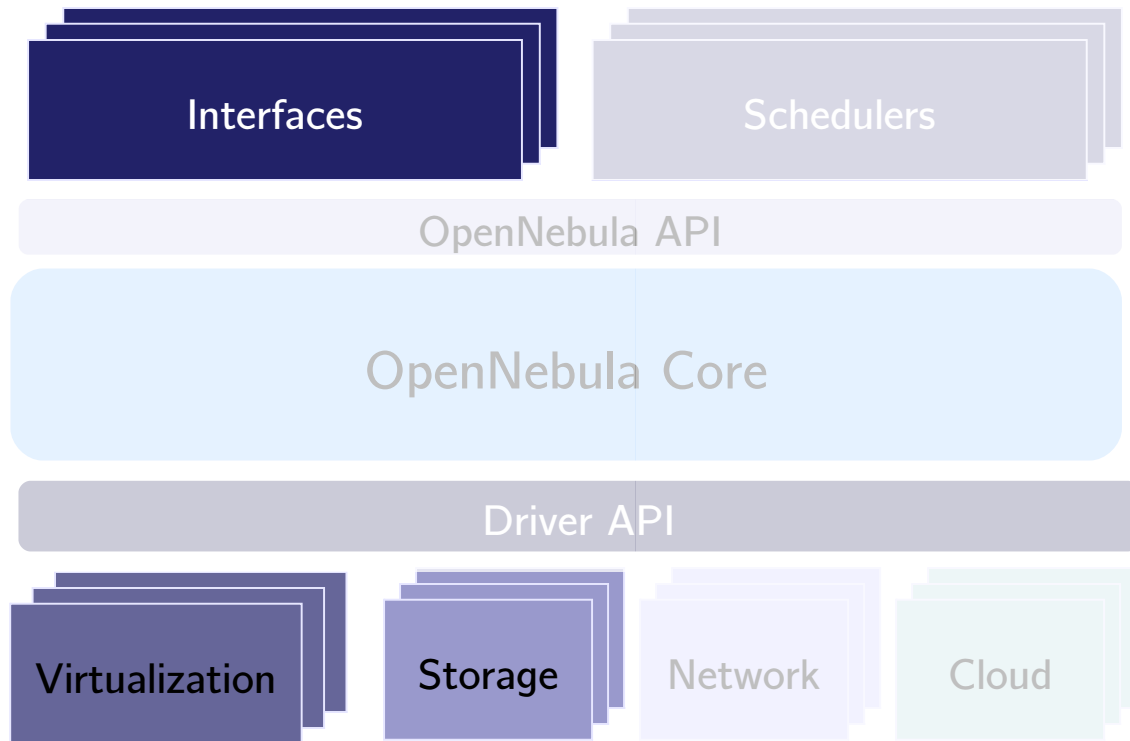


scp-wave

Disk image deployment in $O(\log n)$ time

Developed at Clemson University

<https://code.google.com/p/scp-wave/>

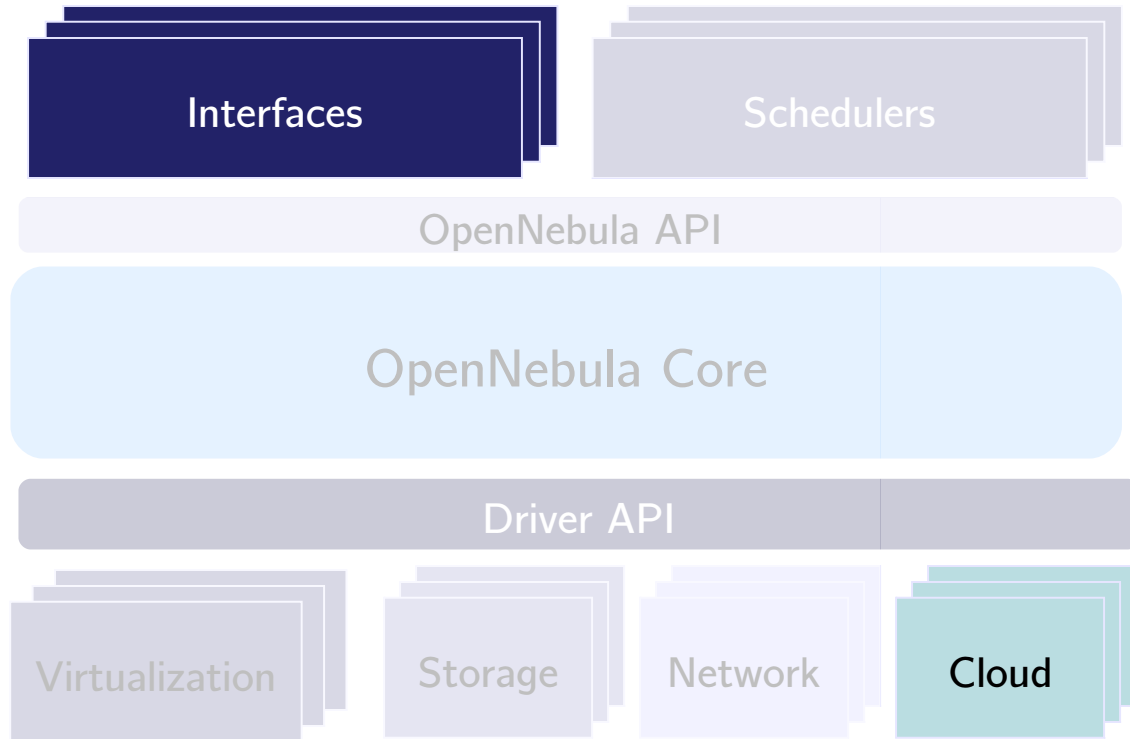


Virtual Cluster Tool

Instantiate, deploys and saves virtual clusters as atomic, self-consistent entities.

Developed at Center for Advanced Studies, Research and Development in Sardinia

<http://dc.crs4.it/projects/vida>



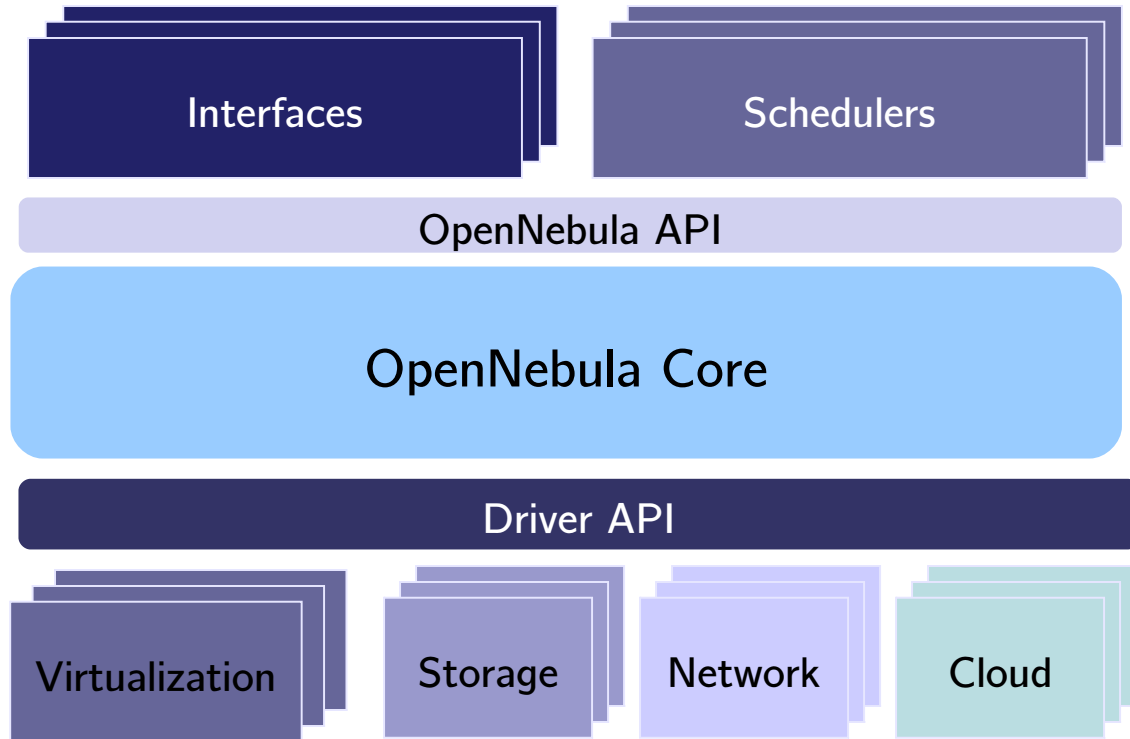
Deltacloud driver and adaptor

OGF OCCI API driver for the RedHat DeltaCloud Framework.

<http://deltacloud.org/drivers.html>

Adaptor for hybrid cloud computer

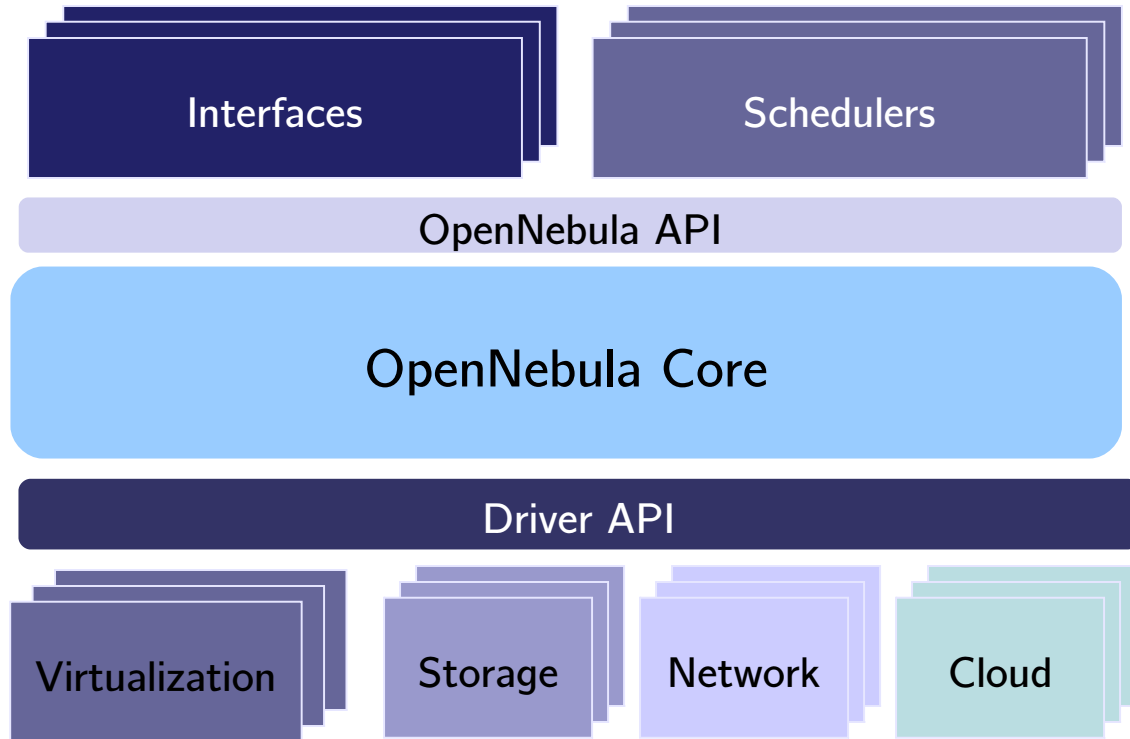
<http://dev.opennebula.org/projects/deltacloud-adaptor/wiki>



Chef recipes

A collection of Chef recipes to automate deployment and management of an OpenNebula cluster.

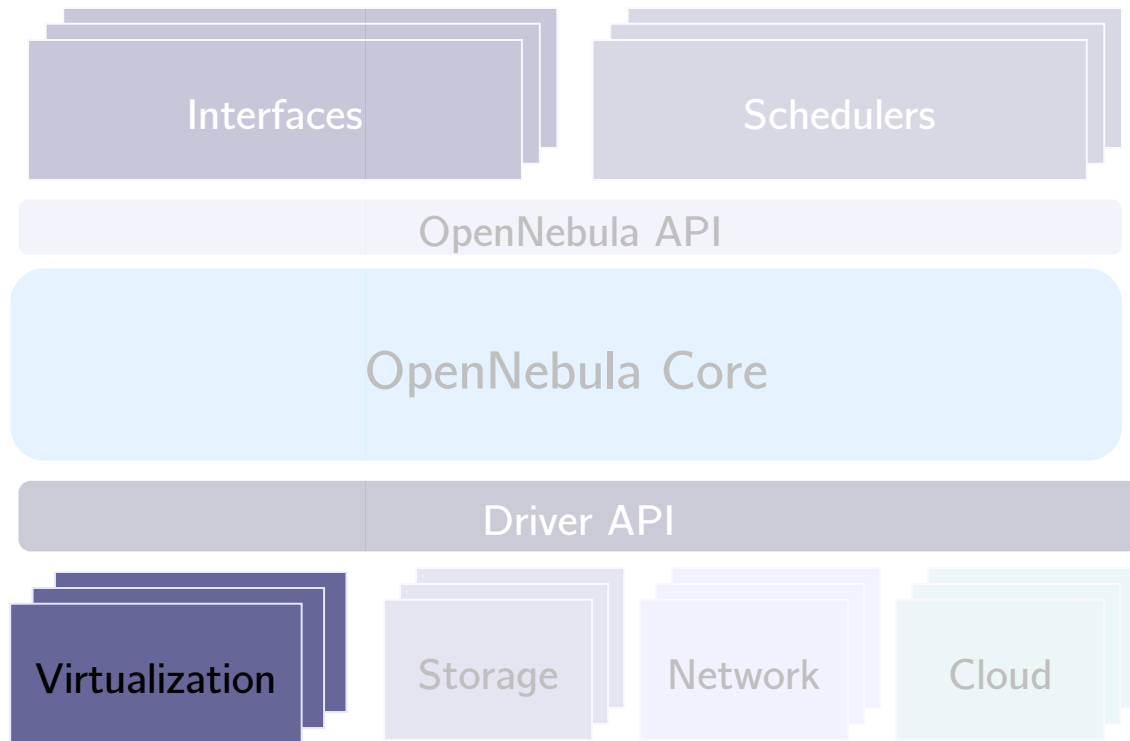
<http://www.cloudboot.com/>



OpenNebula Express

Installer that eases the installation and deployment of OpenNebula clouds.

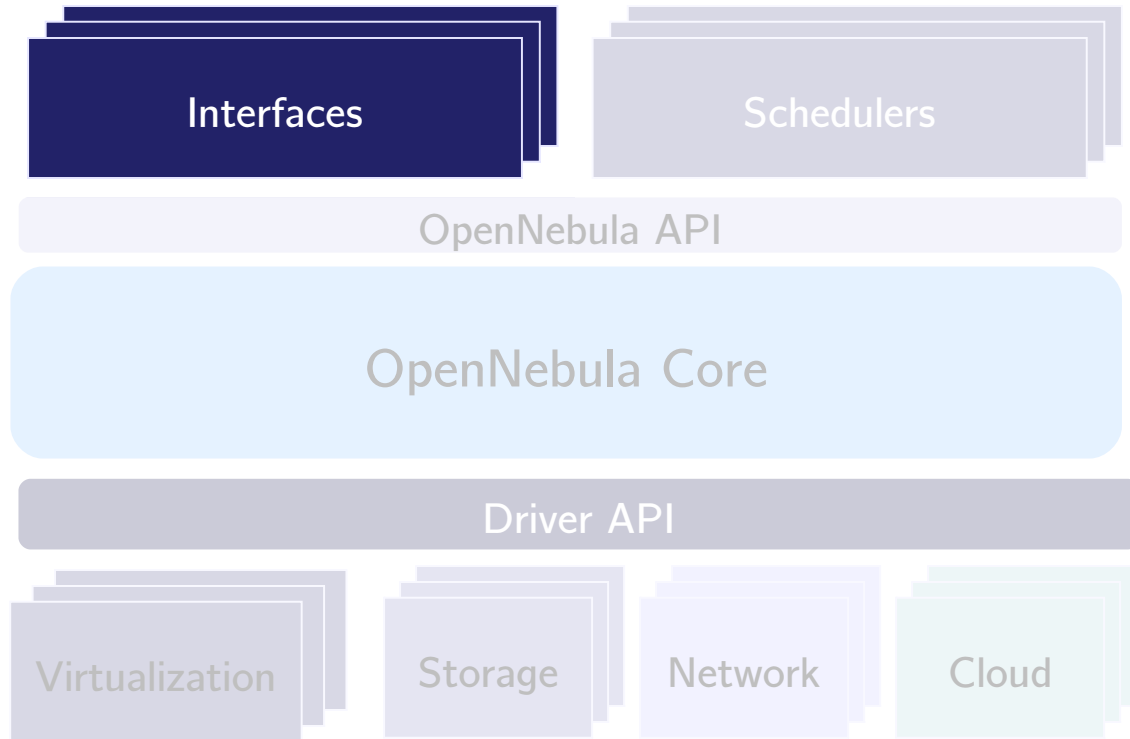
<http://dev.opennebula.org/projects/opennebula-express/wiki>



SNMP Information Driver

Allows Opennebula to use SNMP to monitor host nodes rather than the default SSH.

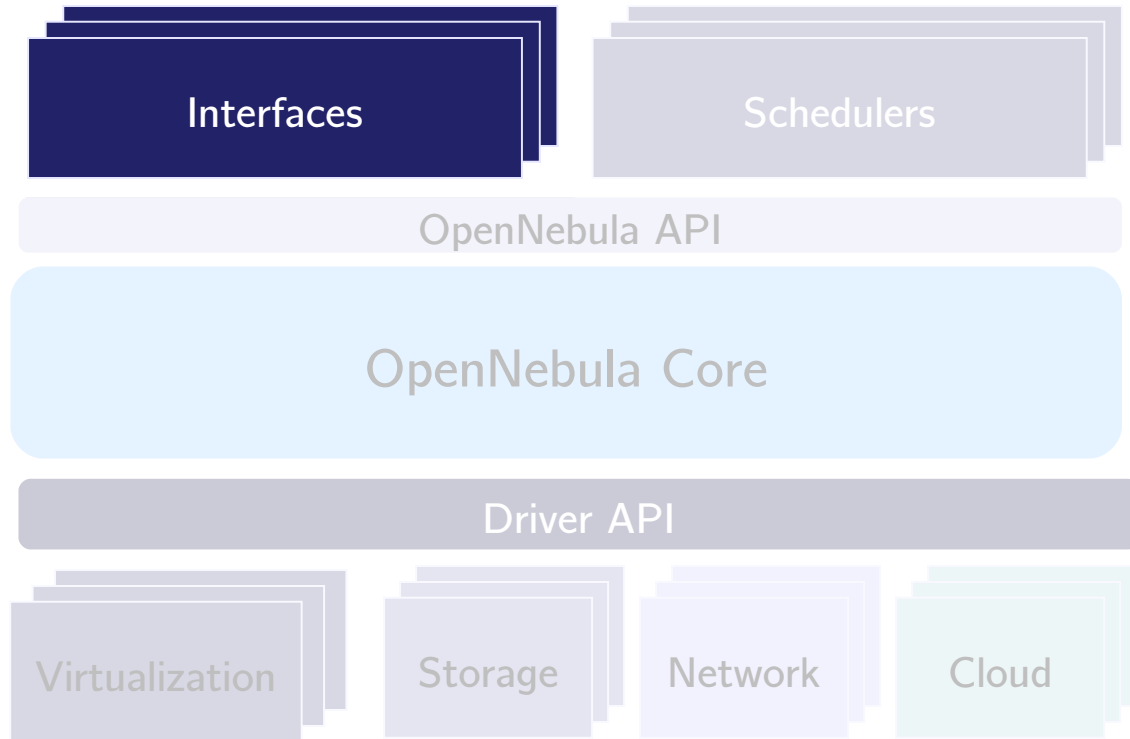
http://opennebula.org/software:ecosystem:snmp_im_driver



Libcloud driver

OGF OCCI API driver for Apache Libcloud

<http://incubator.apache.org/libcloud/>



Management Console

Web interface for OpenNebula

Developed at SARA, Academic HPC center of Amsterdam

<http://dev.opennebula.org/projects/management-console>



Google Summer of Code 2010 projects

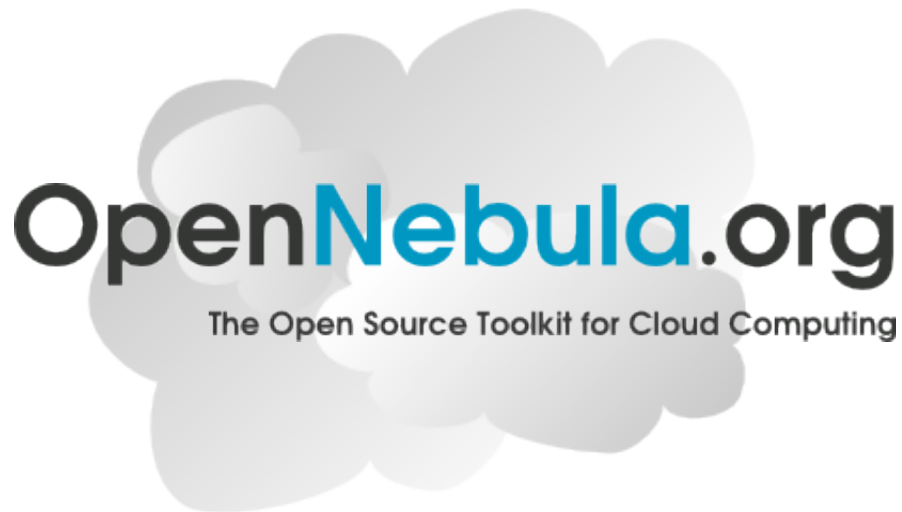
Management Console (II)

Service Manager

Improving Haizea+OpenNebula integration

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OpenNebula 2.0 Features

Image repository

Improved scalability

Multi-cluster support

Authentication/Authorization drivers

Improved EC2 support

MySQL support

More details:

<http://tinyurl.com/opennebula-2-0-beta1>

OpenNebula 2.0

July 28 → Beta 1

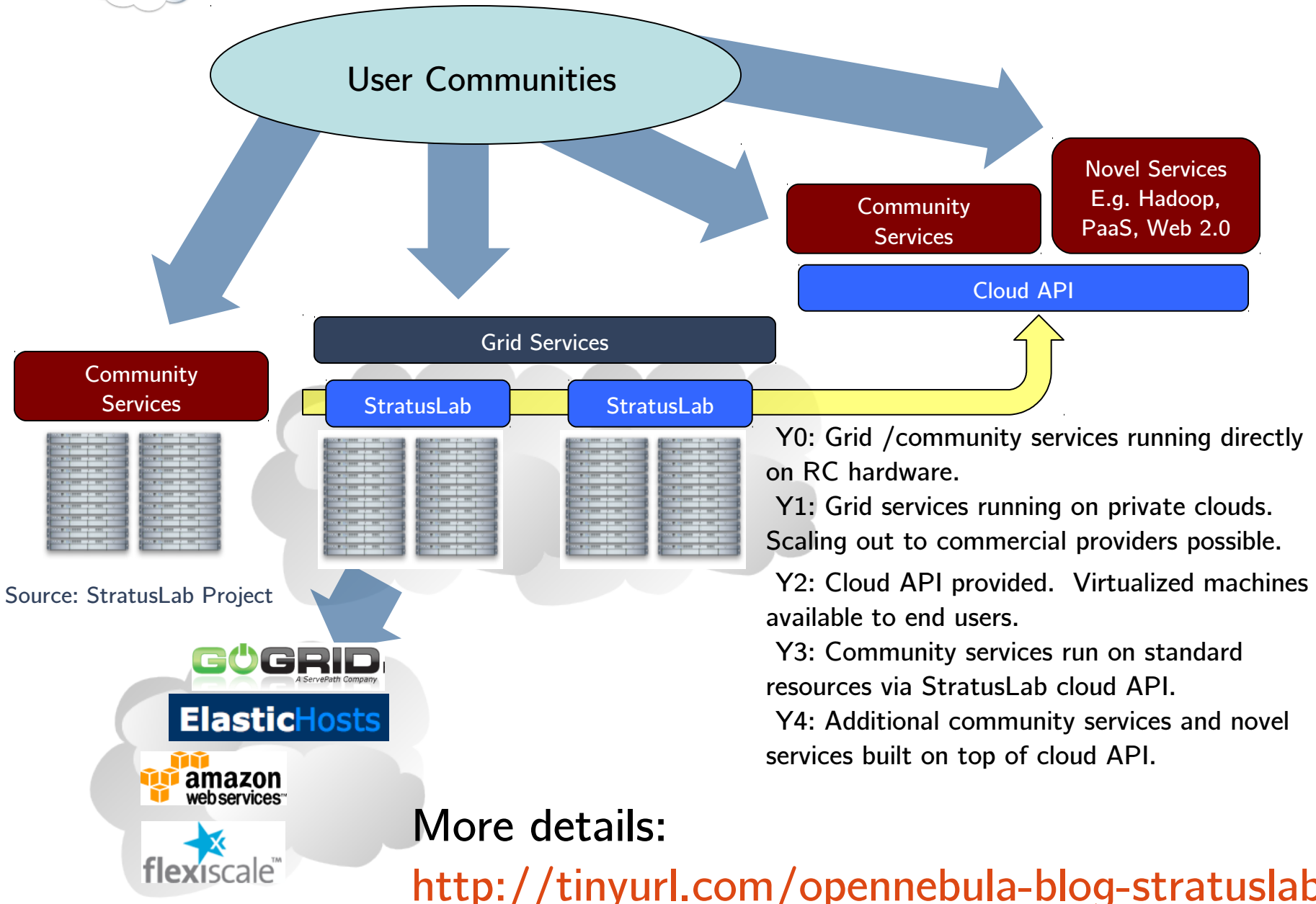
August 31 → Beta 2

September 6 → Release Candidate

September 14 → Final release

Research funding guaranteed until 2013

- RESERVOIR– Resources and Services Virtualization without Barriers, 2008-2011, EU grant agreement 215605
- HPCcloud - Distributed Virtual Infrastructures to Provision Resources, 2010-2012, MICINN TIN2009-07146
- NUBA - Normalized Usage of Business-oriented Architectures, 2009-2011, MITyC Avanza TSI-020301-2009-30
- MEADIANET - Integración de Servicios Multimedia de Siguiete Generación en la Internet del Futuro, 2010-2013, Comunidad de Madrid S2009/TIC-1468
- Recently approved: StratusLab, BonFIRE, 4CAAST





C12G Labs is a privately-held, self-funded company, started by the authors of OpenNebula in order to provide value-added enterprise-grade solutions around it.

The screenshot shows the C12G Labs website homepage. At the top, the C12G LABS logo is on the left, and navigation links for 'partner login', 'contact us', and social media icons are in the center. The tagline 'OPENNEBULA FOR THE ENTERPRISE' is on the right. Below this is a dark navigation bar with links: Home, Products, Services, Partners, Resources, and About Us. The main content area features a large blue banner for 'OPENNEBULA ENTERPRISE EDITION >' with the text 'Your Cloud Management Solution to build a custom Cloud Service, Product or Solution.' To the right of the banner is a diagram with three clouds labeled 'Your Solution', 'Your Service', and 'Your Product', all connected to a central cloud labeled 'C12G OpenNebula'. Below the banner are two columns of text. The left column is titled 'About C12G Labs' and describes the company's mission. The right column is titled 'Answering Questions' and lists four bullet points. At the bottom, there are three columns: 'Top Site Information' with links to FAQs, White Papers, Partner Programs, and the OpenNebula Community; 'Contact Us' with contact details for Partnership, Contact, Skype, USA, and Europe/UK; and 'From Our Blog' with a link to a blog post. A footer at the very bottom contains copyright information and a request to send comments to the webmaster.

C12G LABS partner login | contact us |

OPENNEBULA FOR THE ENTERPRISE

Home Products Services Partners Resources About Us

OPENNEBULA ENTERPRISE EDITION >
Your Cloud Management Solution to build a custom Cloud Service, Product or Solution.

Your Solution Your Service Your Product
C12G OpenNebula

About C12G Labs
C12G Labs provides value-added solutions around the certified and supported Enterprise Edition of the widely-used OpenNebula toolkit for Cloud Computing. Strong partner relationships are the foundation of C12G Labs, providing our customers and partners with an enterprise-grade and flexible cloud management technology that meets the performance, integration and configuration requirements of their infrastructure, processes or use cases to build custom Cloud services, solutions or products.

Answering Questions

- Why OpenNebula?
- Why OpenNebula Enterprise?
- Why Being a C12G's Partner?
- What is our Value Proposition?

Top Site Information

- Frequently Asked Questions
- White Papers
- Partner Programs
- OpenNebula Community

Contact Us

- Partnership: partners@c12g.com
- Contact: contact@c12g.com
- Skype: C12G_OpenNebula
- USA: +1 650 646 3820
- Europe/UK: +44 20 7193 1748

From Our Blog

- OpenNebula Cloud Toolkit Goes Commercial - May 5, 2010

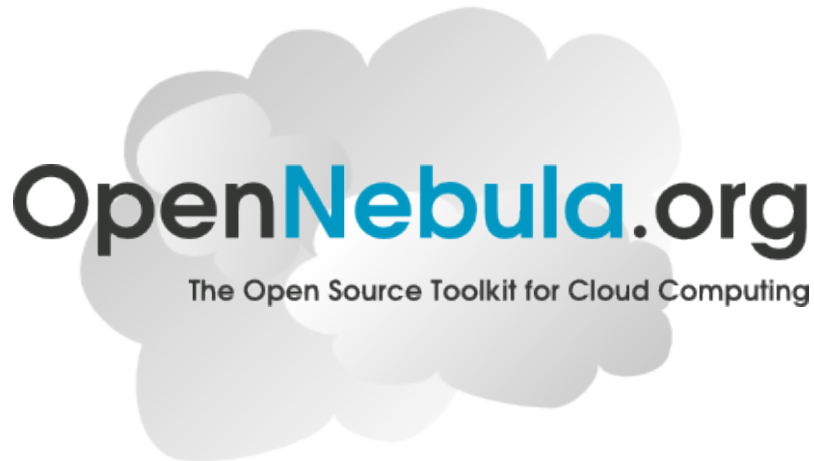
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<http://www.c12g.com/>

Questions?

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